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14. ABSTRACT

This DURIP equipment grant is in support of MIT's Humans and Automation Laboratory's (HAL) human supervisory control research in the field of futuristic command and control (C2). This grant allowed for the fabrication of a state-of-the-art, mobile, experimental C2 testbed. It is projected that this piece of equipment will be used for a minimum of ten years in command and control decision support experiments which necessitate travel to various locations on the East Coast of the United States and Canada. The use of this new piece of equipment will allow for experimental costs reduction, greater research convenience, outreach efforts, as well as for more reliable and realistic research settings. It will also give access to subject-matter experts and military personnel who otherwise would not be able to take part in our research.

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Decision support, mobile command and control, experimental test bed

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DURIP Grant Final Report

The Mobile Advanced Command and Control Station (MACCS) Experimental Testbed

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LONG TERM GOALS

This DURIP equipment grant is in support of MIT's Humans and Automation Laboratory's (HAL) human supervisory control research in the field of futuristic command and control (C2). This grant allowed for the fabrication of a state-of-the-art, mobile, experimental C2 testbed. It is projected that this piece of equipment will be used for a minimum of ten years in command and control decision support experiments which necessitate travel to various locations on the East Coast of the United States and Canada. The use of this new piece of equipment will allow for experimental costs reduction, greater research convenience, outreach efforts, as well as for more reliable and realistic research settings. It will also give access to subject-matter experts and military personnel who otherwise would not be able to take part in our research.

OBJECTIVES

Activity associated with this grant has concentrated on the fabrication, testing and deployment of MACCS, the Mobile Advanced Command and Control Station. The main objective of this project was to integrate a replica of the U.S. Navy's Multi-Modal Work Station (MMWS) into a commercial vehicle, as a safe and reliable mean to conduct research outside of our laboratory and offices (rather than shipping equipment via air). Additional objectives included making this mobile MMWS reconfigurable (for one or several operators), equipping the station with a reliable communication system, creating a realistic environment mimicking the conditions of C2 operations, and providing support for experimenters.

APPROACH

A 5-step approach was defined to implement this project:

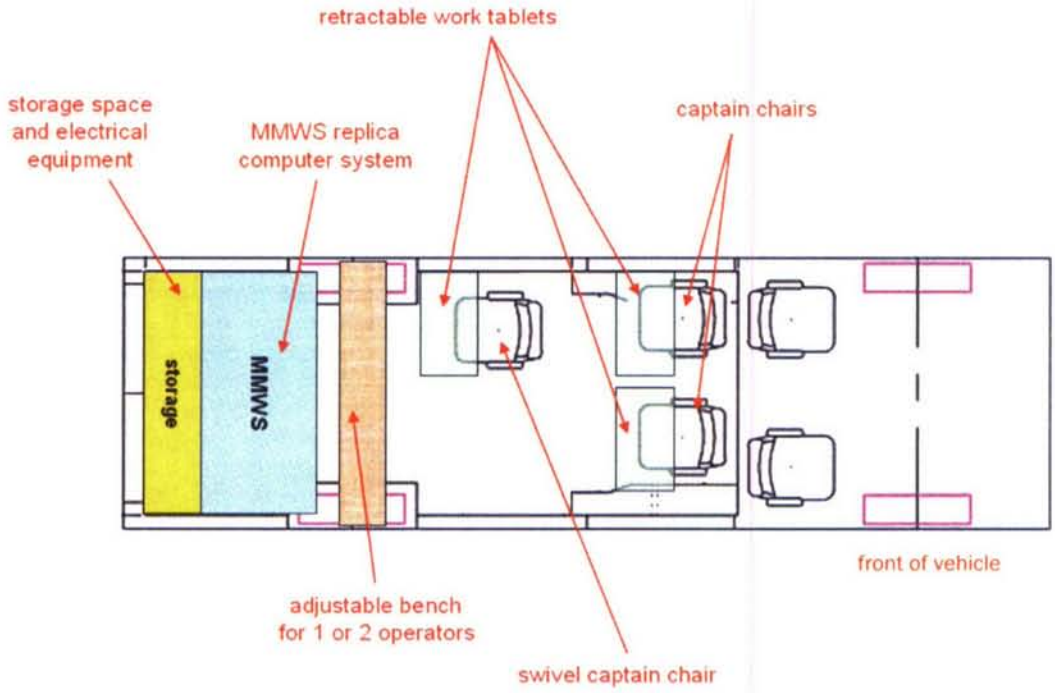
1. Habitability Design
2. Equipment Design
3. Selection of Vendors and Implementation
4. Testing
5. Deployment

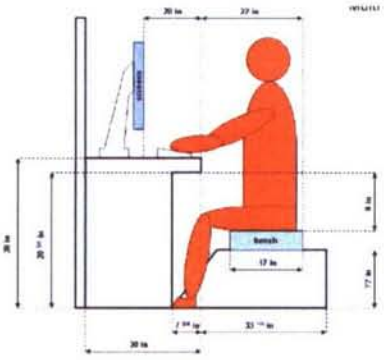
MACCS is now fully operational. The sections below detail the five steps of the project.

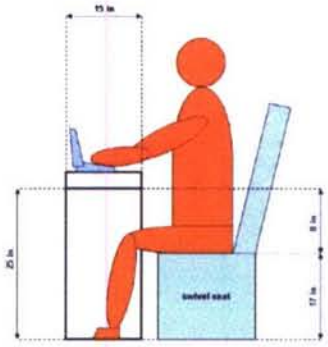
1. Habitability Design

The first phase of this project was aimed at design the inside of the vehicle, in order to make it both habitable and suitable for experiments. Footprint design, 3D modeling and ergonomics renderings were computed to offer the best compromise between space and accommodations. The figures below give an example of the work accomplished.

The cargo section of the van was design to accommodate a maximum of five adult operators: up to two console operators seated on an adjustable bench in front of a MMWS replica (located at the back of the vehicle), and three operators (e.g., intelligence support, communication officers, supervising commander, or experimenters) seated in individual captain chairs in the center part of the vehicle. These three seats are equipped with seatbelts and are suitable for use when the vehicle is moving. Each of these three captain chairs is equipped with a retractable work tablet, which can withhold the weight of a laptop or paper documentation, allowing these operators to conduct their tasks. Each station is equipped with electrical outlets. The captain chair closest to the bench can swivel 180 degrees, in order to allow it to face the two other captain chairs. This configuration is suitable for meeting purposes.







2. Equipment Design

The second phase of this project defined what equipment would be included in the vehicle. Here is a partial listing of these requirements, grouped in categories:

Vehicle

- Cargo space tall enough to stand up (~6 feet)
- Cargo space long enough to contain the MMWS replica
- Operated with a regular driver's license

Computer system

- MMWS Replica
  - Tower computer with dual-processors (to allow two simultaneous users)
  - 6-screen wall display
  - Spatial audio system
- Support computers
  - Apple computer dedicated to video conferencing
  - Handheld computer dedicated to mobile computing (inside and around the vehicle)
  - Panasonic Toughbook computer for military simulation

Communication

- Satellite internet (for internet connection and VoIP (voice over internet protocol) via roof-mounted dish
- Bluetooth headsets
- Private wireless network
- Radios
- Web-based camera

Safety and security

- Rear camera system for backing up
- GPS navigation display
- 4-door alarm system
- Tinted windows

- Lo-jack
- Roadside assistance kit
- Emergency equipment (flashlights, reflecting cones, jumper cables, etc…)

Electrical system
- Shore-line power
- Batteries for autonomous settings
- Surge protection device
- Uninterruptible power supply device
- Electrical outlets throughout the van

Habitability equipment
- 2 regular captain chairs
- 1 swivel captain chair
- 3 retractable tablet supports
- Adjustable bench
- Support desk for computer system
- Air conditioning unit
- Wall and ceiling acoustic outfitting

3. Selection of Vendors and Implementation

The following vendors were selected:

Vehicle: Dodge (Sprinter 2500 high-roof - Mercedes-Benz vehicle)
Electrical equipment and habitability equipment: Crossroads Coaches (Massachusetts small business)
MMWS replica: Digital Tigers
Other computer equipment: GovConnection
Electronics: Circuit City and Best Buy

4. Testing

While the vehicle was being outfitted with all equipment, a team of graduate students from the Humans and Automation Lab was tasked with regularly testing the equipment and the setup inside the vehicle to ensure proper fabrication.

5. Deployment

The deployment phase consisted in providing future users of the vehicle and its equipment with adequate training and documentation. Two driving training sessions and various demonstrations of the equipment (both *in situ* and remotely) were organized, including demonstrations at the ASNE 2007 Human Systems Integration Conference in Annapolis, MD, the 2007 International Command and Control Research Symposium in Newport, RI, and the Naval Undersea Warfare Center in Newport, RI. Two experiments are scheduled in the short term for the van. The first is planned to test UAV time-sensitive targeting displays using Naval officers from the Surface Warfare Officers School in Newport, RI as well as a possible trip to Washington DC to test decision support displays for Air Force acquisition planning.

Internal and external pictures of the van are detailed below.


MIT
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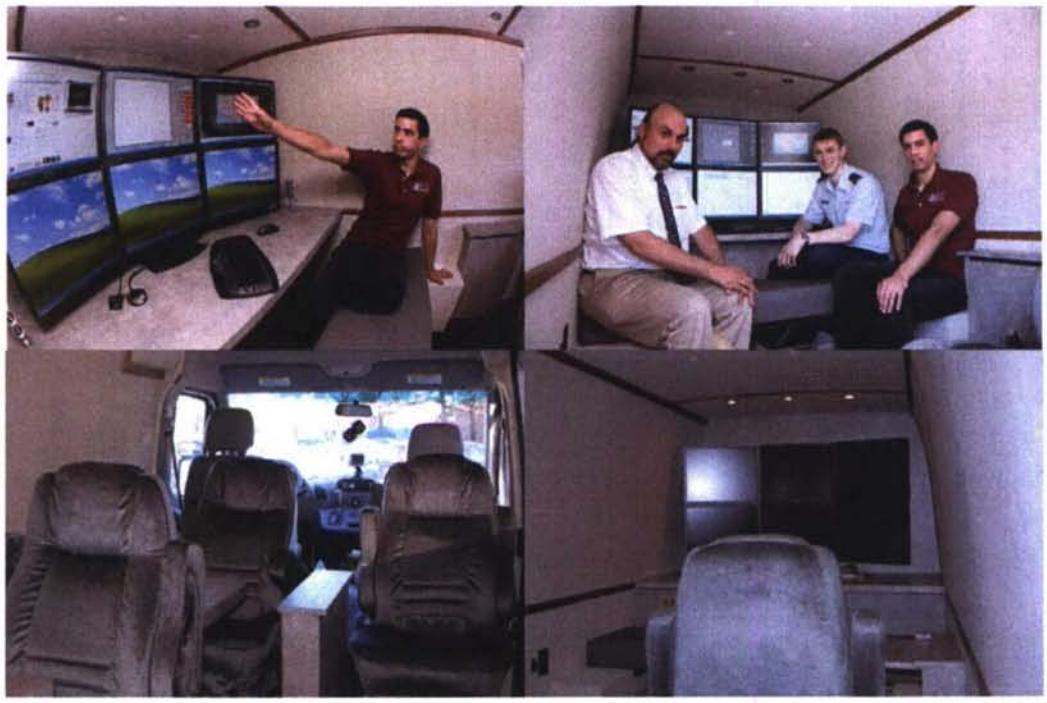
ONR
MIT
Humans and Automation Laboratory



credits: NUWC Imaging Service (NAVSEA), Bill Litant (MIT), Sylvain Bruni (MIT/HAL)

RESULTS

MACCS has been successfully fabricated, tested, and deployed. The various objectives mentioned earlier have been reached. In addition, due to cost-savings and tight budget monitoring, the overall project came in under-budget ($98,941.40 of the original budget of $106,535.00 was spent). It was decided to use the remaining funds to contribute to the acquisition of additional research equipment, namely an eye-tracking system. The funds used were earmarked to pay for specific eye-tracking equipment which will be installed in the MACCS vehicle. This will allow for further research capabilities in this innovative, mobile, experimental testbed.

IMPACT/APPLICATIONS

While MACCS clearly supports the research agenda for both HAL and ONR (as well as many other DoD-related institutions), it also contains a significant education component. There are three distinct education components that MACCS supports: university students, military personnel, and other students ranging from K-college via outreach programs.

- University Students: The educational impact of MACCS for students of C2-related research is tremendous. Students not only gain the benefit of working in a realistic command and control setting and learning the technological implications of constructing and maintaining such a complex systems, they also benefit from the exposure they gain in working with real military personnel. This statement underscores the real importance of this project – students learning about not just technology, but how real military operators of different ranks and different career specialties interact with the technology that the students design. HAL represents the bridge from academic technological advances to transitioning technology into the real world. Without easier access to real military personnel in a realistic setting such as what MACCS can provide, the students lose this critical component of interaction with the real people who need their research insights.

- MACCS projects will not be restricted to just MIT HAL students as other C2 projects at MIT such as those through CSAIL (the MIT Computer Science and Artificial Intelligence Laboratory) will be invited to participate as well as other local universities.

- Military Personnel: Students as researchers are not the only beneficiaries from an educational standpoint as those military personnel who participate will also benefit. These military participants will get the chance to see what technology is in developmental stages, and also provide invaluable participatory design guidance and critical feedback essential to both the actual technology but also the framing of the problem. Military personnel who have participated in previous HAL studies are always very enthusiastic and enjoy the chance to have input into the research and development process. This engagement allows them to become stakeholders in the technology of the future and feel good about making long-term contributions to the future of the military.
- Outreach Programs: An additional opportunity brought by MACCS is the possibility for outreach project to neighboring educational institutions. Beside military projects and core aeronautics and astronautics research, a great deal of human-factor-related science and engineering can be taught through actual demonstration of equipment and research (hardware and software) to audiences such as primary and secondary students. This would support the current push for outreach in science and engineering, providing tangible knowledge of what is done at MIT, and inspiring the next generation of scientists and engineers. In addition, MACCS can provide tour opportunities at local school, as well as professional and academic conferences.

RELATED PROJECTS

MACCS will be used in the near and long terms to conduct research both at MIT and with partnering agencies and businesses. Current HAL projects which will benefit from MACCS support include:

- ONR BAA 07-001: Human supervisory control models for C2 of unmanned systems
- ONR STTR N05-017: Plan understanding for mixed-initiative control of autonomous systems
- AFSOR-sponsored project: Developing decision-support for complex systems acquisition

PUBLICATIONS / DEMONSTRATIONS

Demonstrations of MACCS were conducted at the following venues:

- Massachusetts Institute of Technology (MIT), Cambridge, MA, 16 March 2007.
- The 2007 Human Systems Integration Symposium (HSIS), Annapolis, MD, 19-21 March 2007.
- The 12th International Command and Control Research and Technology Symposium (ICCRTS), Newport, RI, 19-21 June 2007.
- NAVSEA's Naval Undersea Warfare Center (NUWC), Newport, RI, 18 June 2007.